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L. O. HOWARD, Chief

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THE RED-BANDED LEAF-ROLLER.[1]

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INTRODUCTION.

A small greenish caterpillar, about three-fourths of an inch long when mature, and known as the red-banded leaf-roller, attacks the foliage of beans, sweet potato, asparagus, strawberry, raspberry, and various other crops, and at times attracts considerable attention. Such was the case in October, 1919, when the species was abundant in and near the District of Columbia.

October 9, 1919, the writer, in company with W. H. White, Bureau of Entomology, noted that the foliage of sweet potato at College Park, Md., showed considerable injury near the petioles or leaf-stems manifested by large, irregular, more or less elongate holes between the ribs. Some of these were made by a leaf-miner and had been cut out earlier in the season, but many were the work of this leaf-roller which had tied or joined the leaves in different manners. In some cases the leaves were folded between the midrib and the next rib, and the larva had gouged out a hole about twice this length and half the width. Where the leaves were joined the surface at one end was lined with silk. In many cases the larva joined the leaves near the middle of one side and cut out a similar hole, constructing its tent-like shelter at one end.

A very considerable proportion of the top leaves had been attacked by this species and the leaf-miner, but at the time these observations were made there were many more parasites and parasitic cocoons present on the leaves than larvæ.

[1] *Eulia velutinana* Walk.; family Tortricidae, order Lepidoptera.

October 27, 28, and 31, 1919, Miss Marion T. Van Horn collected this leaf-roller in war gardens at Potomac Park in the District of Columbia on sweet potato and on lima and other beans. The leaf-rollers were found in particular abundance where sweet potato and bean vines grew together. Half a dozen or more larvæ were frequently found in a hill, while many rolled and webbed leaves proved that the larvæ had been quite plentiful earlier in the season.

It was noted that toward the end of October and the early days of November the larvæ rolled the leaves from the sides and from the ends, making a more substantial shelter than when they were immature, and lined it with white silk preparatory to pupation.

The fact is noteworthy that this species was more numerous on sweet potato and beans in 1919 than in previous years, the first being an unrecorded food plant. In former years this species has sometimes occurred in raspberry quite as abundantly as the strawberry leaf-roller (*Ancylis comptana* Froehl.).

DESCRIPTIVE.

THE MOTH.

The moth which produces the red-banded leaf-roller is a small, mottled brown form with the fore-wings having an expanse of between a little more than half to nearly three-fourths of an inch (13 to 19 mm.). The pattern of the fore-wings varies to a considerable extent. In the female there is a large, median, dark reddish-brown band running obliquely from the middle of the costa to the tornus, a subapical, irregular, smaller one, and a third postero-basal patch of the same color. The lighter parts of the wings are pale reddish brown, arranged in irregular bands with borders of pale yellow and silver white. The hind-wings are infuscated, with wide white borders and an inner ciliary line. The abdomen is dark gray and the tufts of the head and thorax are reddish brown.

The females are usually considerably larger than the males, with rather more distinct and larger patterns.

The female moth is shown in figure 1 with expanded wings at *a*, and in natural position, when at rest with the wings folded, at *b*. Technical descriptions have been given in so many available publications that a more complete one than here given may be dispensed with for the present purpose. The synonymy is as follows:

Eulia velutinana Walker.

Cacoecia (?) *velutinana* Walker, 1863, List Lep. Brit. Mus., p. 314.
Cacoecia triferana Walker, 1863, l. c., p. 314.
Tortrix incertana Clemens, 1865, Proc. Ent. Soc. Phila., v. 5, p. 138.
Tortrix lutosana Clemens, 1865, l. c., p. 138.
Lophoderus triferanus Walker, Walsingham, 1879, Lep. Het. Brit. Mus., pt. IV, p. 15.
Eulia triferana Walker.

THE EGG.

The eggs resemble those of other leaf-rolling species of Tortricidae. They are much flattened to the surface upon which they are deposited, and to which they tightly adhere, are scale-like in appearance, and overlap, are very pale dull-yellowish in color, the surface finely granulate and moderately shining. The length is about 0.8 mm. to 0.85 mm. (0.03 inch) and the width 0.7 mm.

THE LARVA.

The larva is shown in figure 1, *c*. It suggests at first glance *Epagoge sulfureana* Clem., with which it agrees in many respects. It is, however, larger and readily distinguishable by the lighter and more nearly uniform color of the head and thoracic plate; the head is perceptibly yellowish or light brownish in life but the plate can scarcely be distinguished from the general color of the body. The two lobes are closely joined at the middle, being separated by a very narrow strip of lighter color. The two lateral piliferous spots below the thoracic plate are pale. In Dichelia, on the other hand, the head and thoracic plates and lateral thoracic spots are a decided brown, the latter well chitinized and with a darker posterior margin.

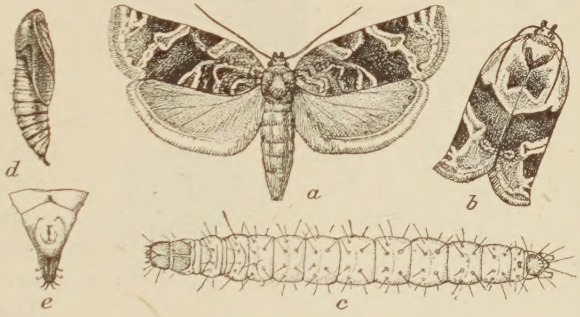

FIG. 1.—Red-banded leaf-roller (*Eulia velutinana*): *a*, Female moth; *b*, moth with wings folded at rest; *c*, larva, dorsal view; *d*, pupa, lateral view; *e*, tip of abdomen of pupa, showing abdominal hooks. *a–d*, About three times natural size; *e*, more enlarged.

The form is elongate cylindrical, about 8 or 9 times as long as wide when extended. The piliferous tubercles are larger and more prominent, but in their arrangement as well as in the vestiture itself they are very like Epagoge.

The entire surface of the body except the head is in life a rather pale grass-green much mixed with yellow, the dorsal surface being a little lighter and the head less greenish and tinged lightly with brown. In alcohol the dorsal surface, including head and thorax, becomes pale yellow, except at the sutures, where the remaining white color of the body is visible. Partially grown larvæ (8 mm. long) are uniform pale green.

The thoracic legs are just perceptibly darker, as a rule, than the abdomen, and the apices of the tarsi are infuscated.

The form is less flattened than in Dichelia, otherwise the shape of the body and of the head, thorax, and legs is very similar. The last segment is of the appearance shown in figure 2 at *c*, the anal plate presenting no special characters worthy of notice, although the extreme apex is remarkable on account of the comb-like process, consisting of 6 spines, with which it is armed.

The length of the largest full-grown larva is about 0.7 inch (18 to 19 mm.); the width, 0.8 inch (2 to 2.2 mm.). Some larvæ are considerably smaller.

The head and first and second thoracic segments are shown from above, much enlarged, in figure 2, *a*. Figure 2, *b*, shows an abdominal segment with proleg from the side.

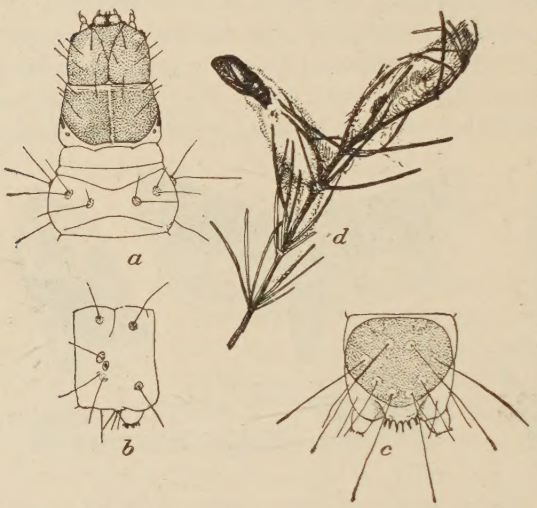

FIG. 2.—Red-banded leaf-roller: *a*, Head and first two thoracic segments, dorsal view; *b*, third abdominal segment, lateral view; *c*, last abdominal segment, from above, showing anal plate and comblike tip; *d*, sprig of asparagus showing web of larva and chrysalis working its way out of web at left. *a*, *b*, *c*, Much enlarged; *d*, somewhat enlarged.

THE PUPA.

The pupa appears still more like that of *Epagoge sulfureana*. It is a little stouter on the average, the greatest width being across the wing-pads. (See fig. 1, *d*.) The last ventral segment, shown from below (fig. 1, *e*), also bears a pair of lateral and two pairs of terminal hooked processes as in Epagoge (eight in all).

The length is about 0.4 inch (8 to 10 mm.), the width is about 0.1 inch (2.2 to 3 mm.).

DISTRIBUTION.

Eulia velutinana is native to this country, and has been known for a considerable number of years from Maine to Texas.

It is well established in the Transition Life Zone and available records show greater abundance there and in the northern portion of the Upper Austral, although it is to be found also in the Lower Austral. Possibly it has been introduced into California through commerce with the East. (See map, fig. 3.)

INJURIES AND OCCURRENCES.

The records of the Bureau of Entomology show a wide diversity in larval food habits. The earliest are those of Dr. C. V. Riley made at St. Louis, Mo., or in that vicinity. The rearing of this insect on grapes was noted July 28, 1870, and the issuance of the moth from larvæ found on raspberry was noted August 4, 1876.

June 11, 1879, pupæ were found rolled up in the leaves of red clover, from which the moths emerged June 13. June 23 another moth issued from larvæ feeding on clover June 10, and the following day an additional specimen issued from a larva feeding on white clover. August 11 a moth was reared from a pupa found spun up on a leaf of apple August 7. October 12 the larva was found on aspen and the moth issued December 10.

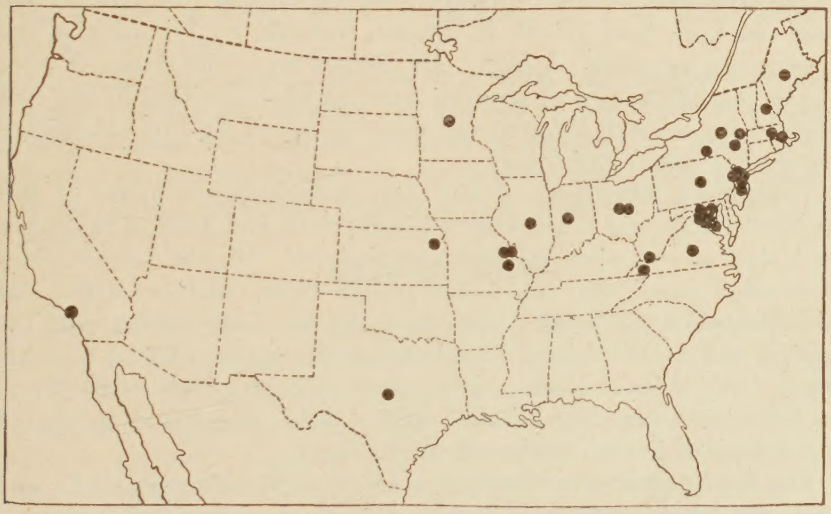

FIG. 3.—Distribution of the red-banded leaf-roller.

June 15, 1882, the moth was reared from larvæ found on apple in the District of Columbia.

Moths were reared June 7, 1885, from larvæ taken on Solidago.

June 12, 1886, the moth was reared from larvæ taken on roses, and on July 27 from others taken on privet and on willow. There is also a note on the rearing of this species June 7, 1886, from the galls of a species of Phylloxera.

This species was reared by Mr. Albert Koebele at Los Angeles County, Calif., from material found on the leaves of orange, April 24, 1888; and on July 26, 1893, specimens were received from Mr. J. G. Barlow, Cadet, Mo., with the report that the larvæ were found boring in the tips of chrysanthemums.

August 13, 1897, the moth was reared from larvæ which had been feeding on violet in the District of Columbia.

There are also three notes on specimens collected by Miss Mary E. Murtfeldt, presumably at her home at Kirkwood, Mo., recording the occurrence of the larvæ on lobelia, smartweed, and asparagus.

May 15, 1898, isolated individuals in the larval stage were observed on the twisted-up leaves contiguous to immature buds of blackberry at River View, Md., the buds having been eaten into in many cases and prevented from blooming. During July larvæ were observed in considerable abundance at Marshall Hall, Md., also on blackberry and on the webbed-up leaves of pigweed (*Amaranthus retroflexus*). Moths issued August 9 and 10.

July 14 to 25, 1899, larvæ were found at Alexandria, Va., by Mr. T. A. Keleher, Bureau of Entomology, on cabbage, raspberry, and cultivated honeysuckle. Moths began to issue July 31. September 26 the larva was received with the information that the material had been obtained from Mr. C. H. Stuart, Newark, N. Y., and that the species was infesting popcorn. Mr. Stuart made the statement that 27 per cent of the ears of popcorn were infested, and that 37 per cent of the corn on each infested ear were destroyed by this caterpillar, an unusual instance of injury.

During the latter part of May and early June the moths of this species were several times observed in the field, and June 13 the moths were seen at rest upon cabbage and rhubarb. On the former plant a deserted pupal skin was found on the under surface of the leaf directly below the point where the moth had been resting, and the midrib was found to have been eaten to the extent of 6 or 8 inches along both sides. Subsequently other cabbage plants were found to have been similarly affected, and a pupa was found in one of these from which the moth afterwards issued.

October 5 larvæ were observed on celery at Washington, D. C., and later the same species was found at work on celery and still more abundantly on asparagus at Brookland, D. C. Later it was observed on parsley, strawberry, and raspberry at Cabin John, Md., and on potted geranium at Washington, D. C. On celery and parsley the larvæ were apparently less abundant, as on these plants they are more difficult to see without close scrutiny, since they web up the leaves very neatly and in such a manner as not readily to attract attention. On asparagus, however, the webs are quite noticeable and could be seen at some little distance. In the formation of their temporary homes, the larvæ use an abundance of silk, often distorting the asparagus stems by drawing them together.

In every instance above mentioned the adults were reared from the material obtained.

In the manner of their attack the larvæ of this species do not differ markedly from those of the sulphur leaf-roller. In work upon corn the young blades are either folded lengthwise so as to form a cylindrical case or simply rolled up as are all other plants when attacked.

This moth was reared December 31, 1903, from larvæ found on cabbage by E. N. Burke, Macon, Ga. The same date the moth was reared from larvæ found on okra in the District of Columbia.

The species was found in great abundance on asparagus in the District of Columbia in the latter days of September, 1904, the larvæ at this time being full grown or nearly so. Many deserted nests were also found, as well as the usual number of spider nests, which so closely resemble those made by the leaf-roller.

Beginning March 23, 1907, the adults of this species issued from foliage of elderberry collected at Arlington, Va., September 3, 1906.

During the last week of October, 1907, Mr. C. H. Popenoe, Bureau of Entomology, observed specimens of this green larva working on species of ground-cherry (Physalis) at Arlington, Va.

The following year he observed the larvæ at Topeka, Kans., working in the tips of ripe ears of sweet corn under the husk, lining the tunnels with silk.

Most of the foregoing records were made from observations of the writer and his associates in the Bureau of Entomology, and there are also some others which need not be mentioned in detail. These include the finding of the larvæ working on zinnia, syringa, hollyhock, snowball, and magnolia. There is also record of attack to catalpa at Welch, W. Va.

BIOLOGIC NOTES.

The larvæ taken on asparagus by Miss Murtfeldt were found October, 1882, and the moths of this lot issued February 21, 1883.

In the writer's recent experience with this insect in the neighborhood of Washington, D. C., nearly all of the larvæ that were obtained in the autumn were approaching maturity during the first week of October, and some had formed their webs for pupation by the middle of that month. By the close of the month all the individuals observed had transformed to pupæ, the moths beginning to issue January 23 and continuing until March 22. In every case that came under observation pupation took place within the larval web or in another close to the place where the larva had been feeding.

The moths kept under unnatural conditions in a warm room issued in January.

A larva obtained from Newark, N. Y., previously mentioned, began forming its cocoon September 28, and the following day appeared to have finished, but further observation showed that it had not entirely completed it, since more silk was added apparently from day to day. It was noted that the larva, before transforming to pupa, cut out a round hole of about the same size or a little larger than the pupa itself. Transformation to this stage took place the first week in October, the moth issuing in January, having been

kept with others in a warm room. There is a singular agreement in the times of pupation and issuance of the specimens at Washington and in Missouri, and of the one individual observed from Newark, N. Y.

In the District of Columbia, and probably elsewhere as well, hibernation takes place exclusively in the pupal state.

From the facts that larvæ have been observed in the open on May 15, that pupæ have been found as early as the second week in June, and that moths have issued during the third week, it was readily surmised that the moths which have hibernated as pupæ appear some time in April and lay eggs for the first generation. The moth was collected during the latter days of April in 1900.

The moths from the first new generation emerge for the most part during the second and third weeks of June, and of the next generation the last of July and the first two weeks of August, the third generation developing in October and early November and wintering as previously mentioned.

It seems to be fairly certain that there are at least two, and probably three generations annually in a climate like that of the District of Columbia and Missouri, and probably no more than two in a more northern latitude like that of the New England States.

From a female captured June 14, eggs were obtained in two masses of about 45 and 65 respectively upon the two following days, and the larvæ hatched in 11 days. The weather was rather cooler than seasonable during this time. A portion of the eggs were placed in a large rearing jar with growing strawberry plants, and the imago obtained July 23, the larval and pupal stages having been passed in 28 days. The weather was extremely hot (80° to 90° F. indoors) during the latter portion of this period, and the pupal stage must have been about 6 days, which would give 22 days or about 3 weeks as the larval period.

Of the larvæ which were collected in the vicinity of the District of Columbia in October, 1919, all had transformed to pupæ by the middle of November and the first moth issued April 15 of the following year, others continuing to issue for a few days thereafter. April 19 an imago was captured at light in the open.

It will thus be seen that the pupal or resting stage of this species for the District of Columbia and vicinity is an even 5 months, leaving 7 months for the active or working periods of the species.

HISTORY OF THE SPECIES.

The species was given its specific name in 1863 by Walker (*1*)[2], who described it under the name of *Cacoecia* (?) *velutinana.*

[2] Italic figures in parentheses refer to "Literature cited," p. 13.

C. triferana, described at the same time, is now considered a synonym, the former name having been given to the male, the latter to the female. In 1865 it was again described as new by Clemens (*2*) as *Tortrix incertana*. Four years later it was redescribed under the same name by Robinson (*3*, *p. 278*). With this last description illustrations of both sexes were furnished.

In 1870 our first account of the habits of this leaf-roller was published by Dr. A. S. Packard (*4*, *p. 40*). It is mentioned as the red-banded cranberry Tortrix or "cranberry worm" and is treated in connection with insects affecting the cranberry in Massachusetts, the account including a description of the adult and a short description of the pupa. This paper was republished in later years (*5*, *6*).

In Dr. C. H. Fernald's catalogue of the Tortricidæ, published in 1882–83 (*7*, *p. 15*), some new localities are added for the species and several new food plants, the latter on the authority of Miss Murtfeldt. Besides cranberry the list includes elm, soft maple, oak, apple, rose, beans, and *Gnaphalium polycephalum*.

It was not until 1885 that any extensive account of the insect was published. This was by Dr. S. A. Forbes (*8*) and is in connection with insects found attacking corn in Illinois. Strawberry and clover are added to the list of food plants.

In 1890, Mr. F. M. Webster (*10*) included this species in a list of insects observed at Lafayette, Ind., affecting salsify. The same year Packard (*11*) wrote again concerning this insect. The following year Prof. Lawrence Bruner (*12*, *p. 267*) mentioned this species briefly in an account of corn insects.

In 1893 Miss M. E. Murtfeldt (*13*) referred to this species as one which webs and curls the leaves of Osage orange. In 1898 the writer (*15*) mentioned it briefly in connection with insects that attack asparagus. There followed Dr. Otto Lugger's short description (*16*), in which it was called the apple Lophoderus.

In 1901 the writer (*17*) recorded the feeding of the larva on violet in the District of Columbia. The same year Felt (*18*, *p. 998*) recorded the depredations of this insect on green popcorn at Newark, N. Y.

In 1904 Slingerland (*19; 20*, *p. 47*) stated that this insect was observed with the grape-berry moth on clusters of blossoms and recently set fruit of grape, and was quite often found at the same destructive work. In reviewing the known food plants, he records attack to Solidago and dogbane and mentions *Urogaster canarsiae* Ashm. as a parasite.

In 1905 Forbes (*21*) again mentions this species as an enemy of Indian corn, and the year following Felt (*22*) includes it in a report on insects affecting park and woodland trees.

FOOD PLANTS.

The red-banded leaf-roller is nearly omnivorous, its food plants comprising many botanical orders. The list follows:

Asparagus, beans, sweet potato, cabbage, horse-radish, celery, parsley, rhubarb, salsify, tomato, sweet corn, pepper, okra, ground cherry (Physalis), blackberry, raspberry, and strawberry among truck crops; chrysanthemum, geranium, rose, lobelia, violet, snowball, syringa, hollyhock, zinnia, privet, and honeysuckle comprise the list of ornamental plants. Other plants affected are clover, field corn and popcorn, cranberry, elderberry, grape, orange, apple, plum, elm, maple, oak, laurel oak, aspen, willow, magnolia, catalpa, balsam fir, and Osage orange. The larva also attacks pigweed (*Amaranthus retroflexus*), goldenrod (*Solidago* spp.), smartweed, dogbane, *Solanum* sp., and *Gnaphalium polycephalum*.

NATURAL ENEMIES.

The red-banded leaf-roller is no exception to a somewhat general rule that larvæ which conceal themselves from view in rolled and webbed leaves and similar places of shelter are the more subject to parasitic attack. The following list of parasites is in evidence:

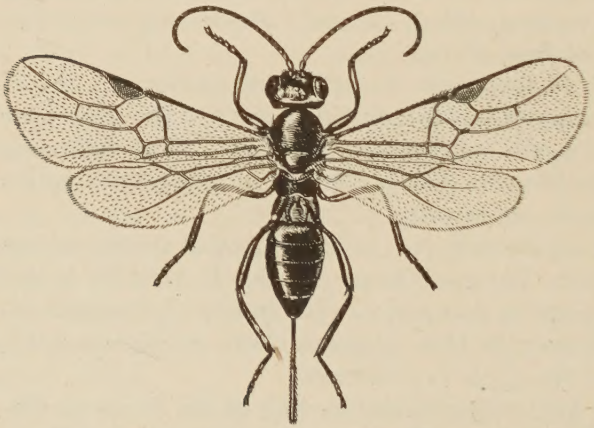

FIG. 4.—*Microbracon* sp., a parasite of the red-banded leaf-roller.

Exochus curvator Fab., an ichneumonid, was reared by the writer August 7, 1900, from the host larva collected at Camerons Mills, Va.[3]

Epiurus indagator Walsh was reared from this leaf-roller on oak at Kirkwood, Mo., November 7, 1878.

An ichneumonid parasite allied to Pimpla was reared from material received from Cadet, Mo., in July, 1893, previously mentioned. (Dept. Agr. No. 5861°.)

Lampronota pleuralis Cress. was reared at St. Louis, Mo., November 7, 1878.

Limnerium sp. is mentioned by F. M. Webster as having been reared with this leaf-roller and two others on salsify.

[3] Identified by Ashmead, who also identified practically all of the other species mentioned unless otherwise noted.

Opius foersteri Gahan, a braconid, wrongly determined as *Opius mellipes* Prov., and published under that name in Insect Life (*9*), was reared from material received from Kirkwood, Mo., September 25, 1881.

Epirhyssalus atriceps Ashm., a minute yellow braconid, was reared from its host July 1, 1907, breeding on rose and collected by Mr. I. J. Condit at Pataskala, Ohio.[4]

Microbracon sp. (fig. 4) was reared from material collected by Mr. M. R. Smith at Plymouth, Ind.

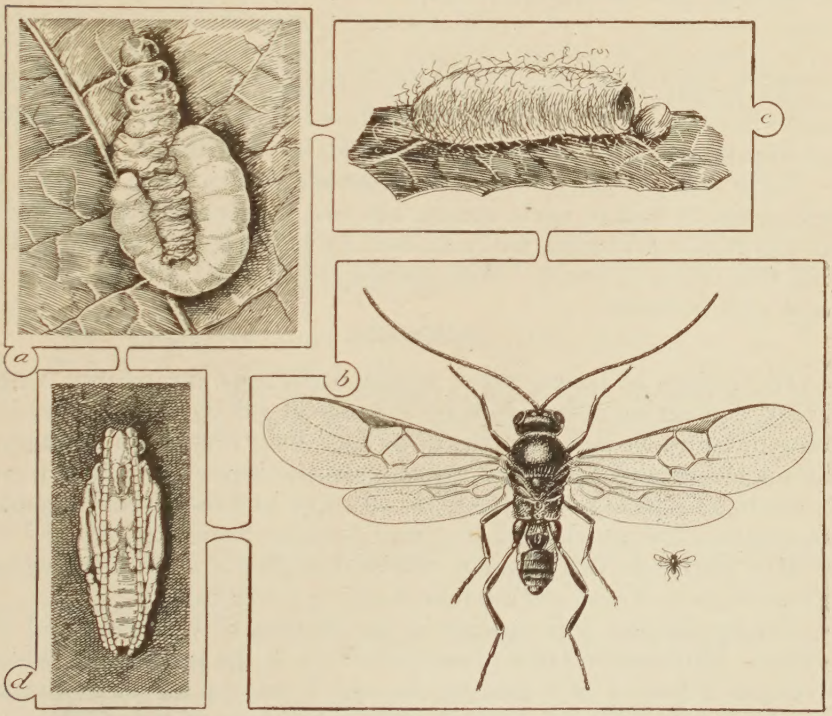

FIG. 5.—*Apanteles canarsiae*, a parasite of the red-banded leaf-roller: *a*, Larva feeding on leaf-roller larva; *b*, adult parasite; *c*, cocoon; *d*, pupa. All much enlarged. (Strauss.)

Smicra deliva Cress., a chalcidid, was reared by the writer during the last week of July and first week of August from raspberry leaves infested by this leaf-roller from Camerons Mills, Va.

Smicra torvina Cress. was reared with the foregoing.

Apanteles canarsiae Ashm. (fig. 5) was reared from this leaf-roller by Slingerland (*20*) in New York, and is somewhat better known as a parasite of the grape leaf-folder (*Desmia funeralis* Hbn.) and some other species.

[4] Identified by Mr. J. C. Crawford.

Phorocera parva Bigot,[5] a tachina fly, is reported as a parasite of this leaf-roller by Coquillett (*14*).

CONTROL.

The red-banded leaf-roller is seldom sufficiently abundant to warrant artificial methods for its control. Since it conceals itself in leaves, rolled or bound together, it would appear difficult to reach it with insecticides, but as it must issue from this shelter to feed on surrounding leafage it can then be reached by the application of arsenicals. The best time to apply these is soon after the eggs are laid. Arsenate of lead is the standard insecticide, used at about 2 or 3 pounds to 50 gallons of water and applied as a spray.

The webbed leaves can be readily detected after a little practice, and when infestation is not too heavy these can be clipped and burned, or they may be pinched so as to crush the larvæ within.

Early fall plowing and burning over the garden after the crop is off, either in fall or early spring, are two farming methods which, if vigorously practiced, will undoubtedly help greatly toward holding this insect in check. They should both be put into practice in case of infestation.

SUMMARY.

The foliage of beans, sweet potato, asparagus, strawberry, raspberry, and various other crops is subject to attack by a small greenish caterpillar about three-fourths of an inch long when mature, known as the red-banded leaf-roller, which rolls the leaves in various ways, according to the nature of the plant attacked, and breeds continuously throughout the growing season, from April to November.

It is native to this country, where it enjoys a wide distribution from Maine to Texas and has been found in California.

The species has been studied in the District of Columbia and vicinity. Hibernation takes place exclusively in the pupal state, which occupies a period of 5 months, leaving 7 months for the active or working stage. The ascertained period of the egg stage is 11 days, of the larva 22 days, and of the pupa a minimum of 6 days. There are at least two and probably three generations annually in the climate where observed.

Several natural enemies, mostly parasites, attack this species.

The red-banded leaf-roller is seldom sufficiently abundant to warrant artificial methods for its control, and since it conceals itself in rolled-up leaves, it is difficult to reach with insecticides. It can, however, be reached with a spray of lead arsenate, inasmuch as it issues from this shelter to feed on surrounding leafage. Clipping the webbed leaves from the affected plants, early fall plowing, and burning over affected areas after the crop is off, will help to hold the insect in check.

[5] Identification by Coquillett.

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